

DECLARATION under 37 C.F.R. § 1.132

The undersigned, Benoit DUBERTRET of 31, avenue René Coty, 75014 Paris, France, herewith declares as follows :

1. I am an expert in the field of nanoparticle physical chemistry. My resume is attached.
2. I am a co-inventor of the U.S. patent application serial number 10/536,736. I am aware of the contents of the pending claims. I have reviewed the Office Actions mailed on 10/11/2007, 04/02/2008, 11/28/2008 and 04/06/2009 and the prior art cited therein.
3. The invention of the application includes a method of using quantum dots as pigments in preparing a colored makeup composition. In such make-up compositions, coloration is produced by the quantum dots, which absorb and emit part of the ambient light. Because the coloration produced depends on the size of the quantum dots, the color conferred is tunable by adjusting the quantum dot's particle size.
4. Quantum dots are semiconductor particles having size dependent properties which differ from the bulk values as a result of quantum confinement. A semiconductor particle is said to be a quantum dot when its diameter is smaller than the Bohr radius of the electron, the hole and the exciton that are created upon absorbing a photon with an energy higher than the band gap. When the particle size is much larger (i.e. particle diameter of 4 times or more the Bohr radius), the material does not exhibit size dependent effect and the properties of the nanoparticles are identical to the bulk material. For CdSe, the Bohr radius is 6nm, and 24nm diameter CdSe particles will have similar emission and absorption spectra than 50nm, 500nm, or even 500 μ m diameter particles. The exciton Bohr radius is strongly material dependent. In the case of CuCl, it is 0.7nm, while it is 36nm for InAs.
5. ZnO nanoparticles with a diameter of 10 - 250nm are not quantum dots, and do not have size dependent properties. In the case of ZnO, the Bohr radius is 1.4nm [1]. Consequently, particles with diameter larger than 5.6nm will have similar optical properties than bulk ZnO.
6. Finely divided ZnO particles with diameter larger than 10nm used as a sunscreen agent cannot be assimilated to quantum dots because for ZnO particles of this size, no size dependent properties will be observed.
7. Further, large ZnO particles (>10nm diameter) will absorb light below the bulk ZnO band gap (around 3.4eV, i.e. 364nm). Above this wavelength, the material is transparent (no absorption). Consequently, this material can be used as UV absorber, but not as a color agent. Very large ZnO particles (diameter>150nm) will appear turbid and slightly white because of light scattering.

8. In contrast, quantum dots may absorb and/or emit light in the visible region depending on size and material and are thus able to confer a tunable, vivid coloration to a make-up composition. The coloration can also change according to the light conditions. In low light conditions, the fluorescence is low, and the color is due only to absorption. In bright light conditions (sun light), fluorescence is mixed with absorption, and different coloration can be obtained.
9. One of the major problems of quantum dots is the sensitivity of their fluorescence to free radicals, charges, hole traps, and more generally surface chemistry (see for example [2]). To be able to include quantum dots into make-up compositions without loss of fluorescence using adapted surface chemistry (core/shell quantum dots (see for example [4]) and optionally micelle encapsulation [3]) was thus not expected.
10. The undersigned declares further that all statements made herein of his knowledge are true and that all statements made on information and belief are believed to be true. Further that these statements were made with the knowledge that wilfully false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code, and that such wilfully false statements may jeopardize the validity of the application and of any patent issued thereon.

Signed this 16 day of May 2009.

May 28 2009



Benoit DUBERTRET

- [1] T. Hirai et al. *Journal of Luminescence*, 112 (2005) 196-199
- [2] Jasieniak, J.; Mulvaney, P. *Journal of the American Chemical Society* 2007, 129, (10), 2841-2848.
- [3] Dubertret, B.; Skourides, P.; Norris, D. J.; Noireaux, V.; Brivanlou, A. H.; Libchaber, A. *Science* 2002, 298, (5599), 1759-1762.
- [4] Mahler, B.; Spinicelli, P.; Buil, S.; Quelin, X.; Hermier, J. P.; Dubertret, B. *Nature Materials* 2008, 7, (8), 659-664.